International Journal of Agricultural
Science and Research (IJASR)
ISSN(P): 2250-0057; ISSN(E): 2321-0087
Vol. 9, Issue 4, Aug 2019, 39-46

AN EFFECT OF SELECTED PARAMETER ON THE FIELD PERFORMANCE OF SWEEP ATTACHED WITH PULVERIZING ROLLER TYPE MECHANICAL WEEDER IN INTER ROW

N. SRIDHAR[1] & D. ASOKAN[2]

[1]*Research Scholar, Department of Farm Machinery and Power Engineering, AEC & RI,*
Tamil Nadu Agricultural University, Kumulur, Trichy, Tamil Nadu, India

[2]*Professor, AEC & RI, Tamil Nadu Agricultural University, Coimbatore, Tamil Nadu, India*

ABSTRACT

Weed control is the most expensive and important farm practice in the crop production system. Mechanical weed control method will facilitate easy and timeliness operation and also improve the soil aeration and water intake capacity. Keeping in view the importance of a mechanical method of weed control, sweep attached with helical type pulverizing roller was developed and tested in actual field condition to evaluate the performance through weeding efficiency and plant damage. It was found that the maximum weeding efficiency of 73.64 percent and minimum plant damage of 7.8 percent was obtained at 1.0 kmph forward speed of operation with 50 mm depth of cut.

***KEYWORDS:** Mechanical Weeding, Sweep & Helical Type Pulverizing Roller*

Received: May 06, 2019; **Accepted:** May 27, 2019; **Published:** Jun 13, 2019; **Paper Id.:** IJASRAUG20197

Original Article

INTRODUCTION

Weed control is laborious and expensive operations in crop production, which accounts for around 25 percent of total labour requirement and one-third of the cost of cultivation. (Nag and Dutta 1979, Rangaswamy *et al.*, 1993). Due to the competitiveness of weeds, delay and negligence in weeding operation affect crop yield up to 30 to 60percent (Singh, 1988, William *et al.*, 2007). Effective weed management is a systematic approach which reduces the impact of weed on crop growth and yield. These practices often allow the crop to utilize all available resources necessary to achieve its yield potential. Mechanical weed control improves the soil aeration, soil nutrient, and water intake capacity and also facilitate easy and timeliness operation. Pullen and Cowell,1997 asses the ability of different mechanical weeding mechanisms to control weeds in actual field condition as follows *viz.*, the duck foot cultivator perform better than other weeding mechanism but caused unacceptable soil movement. The powered rotary hoe worked well at all growth stages but its performance reduced as working speed was increased. The brush weeder ineffective when operating deeper and also in low rotor speed. The ground driven rotary weeder worked better at all operating speeds of weeder but unable to cope with established plant growth. From the above report it is concluded that active and passive tool alone have not attained maximum field efficiency during the field operation while considering this fact in view, the following research were developed and studied on combine tillage. Al. Janobi *et al.*, 1998 reported combined tillage (two or more different types of tillage implements or tools works at the same time) reduce the number of operations in the field. Manian and Kathirvel (2001) reviewed that combined machines are more complex than passive tilling implements and rotary machines, even though these

machines can unite the advantages of active and passive machines. The Combined tillage mechanism reduces the operating time, specific fuel consumption, draft requirement, power requirement, energy requirement and wheel slip in actual field condition when compared with single passive or active tillage implements (Hajiahmad and Javadi (2006), Sahu and Raheman (2006), Shinners *et al.* (1993b)**.** Keeping in view the above facts, a study was undertaken to develop a sweep attached with pulverizing roller for inter-row crops and analyze the effects of the operational parameters on the performance of developed mechanical weeder in actual field conditions.

MATERIALS AND METHODS

The machine parameter such as the forward speed of operation and depth of cut affect the weeding efficiency of tractor operated mechanical inter-row weeders. These parameters should be optimized to achieve maximum weeding efficiency with minimum plant damage. By considering the operational constraints, the 4 levels of the forward speed of operation *viz.,*1.0, 1.5, 2.5, 3.5, and 3 levels of depth of cut *viz.,* 30,50 and 75 mm were selected. A total number of 36 experiments were conducted with selected levels of the variable. The test was conducted in the experimental field no B2-A, Central Farm, AEC&RI, Tamil Nadu Agricultural University, Trichy. The experimental field was initially ploughed with tractor-drawn disc plough followed by two ploughings with cultivator and one rotavator operation. The fine tilth condition of soil achieved. The weeding was done in 25 days after germination (DAG) by developed mechanical weeder. *i.e.*, the critical period of weed competition is around 25 – 30 days for most of the crops.

The mechanical inter-row weeder consists of the mainframe, sweep blade assembly and pulverizing helical roller assembly and depth wheel. The prime power source of mechanical inter-row weeder is tractor and developed unit connected by three-point hitch to the tractor. The schematic drawing of the developed mechanical weeder illustrated using Proe –Creo 5.0 software as shown in Figure 1.

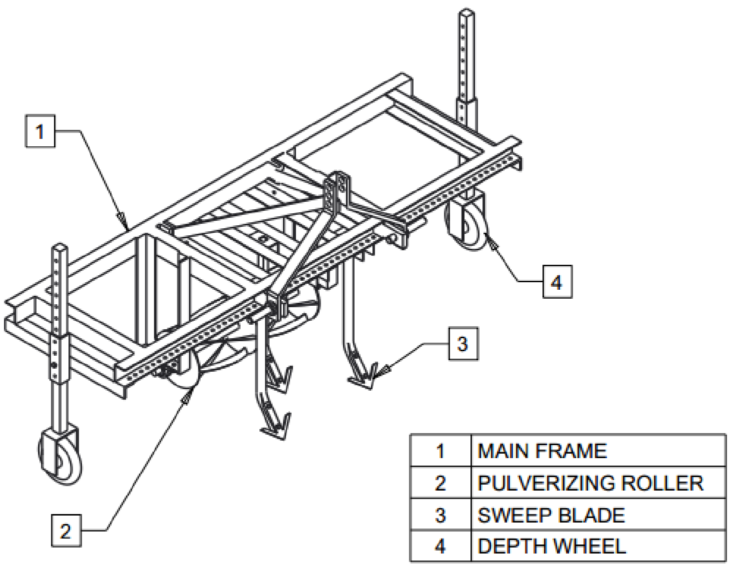

Figure 1: The Schematic Drawing of Developed Inter-Row Weeder

Soil samples were collected randomly from five different locations at depths of 0 to15 cm. These samples were weighed and oven dried on 105 °C for about 24 hours. After the specified time, the oven-dried samples were weighed. The moisture content on a wet basis was calculated as follows

$$M.C_{(wb)} = \frac{W_W - W_d}{W_W} \times 100 \quad (1)$$

Where,

$M.C_{(wb)}$ = Soil moisture content, wet basis(%)

W_w = Weight of the wet sample (g)

W_d = Weight of the oven dried sample (g)

Bulk density is the mass per unit volume of soil including pore space. Measurement of bulk density was carried out in all the experimental sites. The soil sample was manually filled in cylindrical aluminium cups to measure the bulk density. The volume of the container was around 100 cm ^{3}when bulk density was measured; the measurement of moisture content was also made simultaneously.

$$Bulk\ density, (kg\ m^{-3}) = \frac{Mass\ of\ soil\ sample\ ,(g)}{Volume\ of\ container,(cm^3)} \times 100 \quad (2)$$

Cone index represents the force per unit area of the cone base exerted by soil upon the conical head when forced down a specific depth. A penetrometer was used to measure soil cone index. The manually operated digital cone penetrometer was used to measure the cone index as shown in figure 2. The cone base area is 130 mm^2 and 12.83 mm diameter with 9.53 mm diameter shaft was used to measure the cone index. The apex angle of the cone is 30°. The measurement was taken randomly at ten different locations in the experimental field at different depths.

Weeding efficiency is measured by weed counting methods. Weeds from each plot before and after weeding were counted and collected by the quadrant method. To determine weeding efficiency, a quadrant of 500 x 500 mm was placed in the field at random and the number of weeds inside the quadrant was counted before and after weeding. The weeding efficiency was calculated using the following equation (Remesan *et al.*, 2007).

$$\eta_w = \frac{(N_2 - N_1)}{N_1} \times 100 \quad (3)$$

Where,

η_w = weeding efficiency, (%)

N_1 = number of weeds in the quadrant area before weeding

N_2= number of weeds in the quadrant area after weeding

Plant damage was calculated by counting the number of plants in 10m row length before weeding and a number of the plants damaged after weeding. The plant damage was calculated by the following expression (Yadav and pund, 2007)

$$Plant\ damage, (\%) = (\ 1 - \left(\frac{q}{p}\right) \times 100 \quad (4)$$

Where,

q = Number of plants in a 10 m row length after weeding

p = Number of plants in a 10 m row length before weeding

The experiments were conducted with three replication for each forward speed of operation and depth of cut. The weeding efficiency and plant damage mean values are calculated and reported. The effect of the forward speed of operation on weeding efficiency and plant damage was investigated using analysis of variance (ANOVA) at 1 % significance level with the help of WASP 20.0 software.

RESULTS AND DISCUSSIONS

The weeding was done on 25 days after germination of the cotton crop. Before testing of developed mechanical weeder, the experimental field was examined through cone index, soil moisture content and bulk density. The soil average moisture content and bulk density of topsoil at the depth of 0-15 cm were 14.70% (d.b.) and 17.81 g cm^{-3} respectively. A sample of soil penetration resistance profile and the average value of the different location as shown in figure 2, figure 3 and figure 4 respectively.

Figure 2a: Soil Resistance Measured by Digital Cone Penetrometer in Actual Field Condition before Weeding

Figure 2b: Soil Resistance Measured by Digital Cone Penetrometer in Actual Field Condition after Weeding

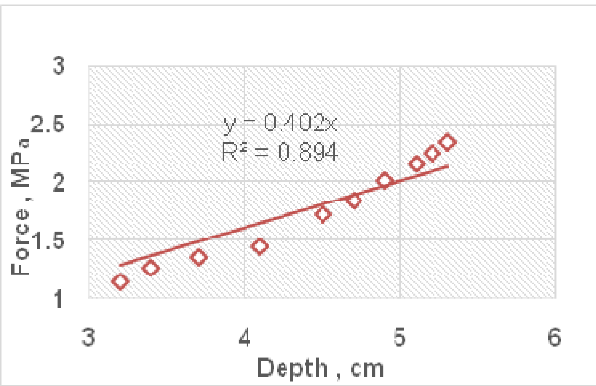

Figure 3: Soil Resistance Profile at Various Depth

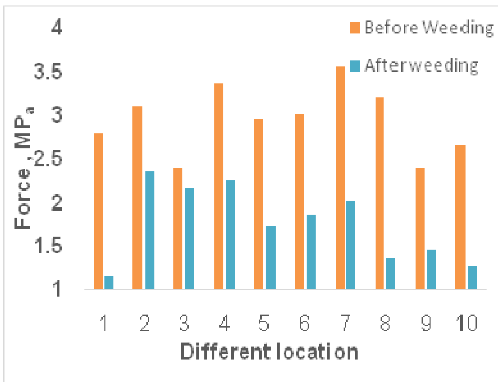

Figure 4: Soil Penetration Resistance for Different Location at before and after Weeding

From the figure 3 and figure 4 interfere that the soil resistance increases with increasing depth of operation or depth of cut. The average soil resistance of 29.2 MPa was registered before weeding at an average depth of 4.2 cm and the same average soil resistance of 17.6 MPa was registered after weeding.

Effect of Forward Speed of Operation on Weeding Efficiency and Plant Damage

The effect of operational parameters *viz.*, Forward speed of operation and depth of cut on weeding efficiency and plant damage of developed mechanical weeder was analyzed and results are shown in figure 6 and figure 7. The operational view of sweep attached with pulverizing roller weeding blade is shown in figure 5

From the figure 6. it was observed that the weeding efficiency decreased 22.26, 18.23 and 38.87 percent, 30.40,19.74 and 22.44 percent and 31.64, 27.3 and 27.93 percent for change of forwarding speed of operation from 1.0 to 3.5 kmph at various depth of cut*viz.,*30, 50 and 75 mm respectively. The maximum weeding efficiency of 73.25 percent was obtained at 1.0 kmph forward speed of operation with 50 mm depth of cut.

Figure 5: Operational View of Sweep Attached with Pulverizing Roller Type Inter-Row Weeder

From figure 7, it was noticed that the plant damage increases as 3.9 to 9.8, 7.8 to 9.8 and 9.8 to 15.7 percent for change of forward speed of operation from 1.0 to 3.5 kmph at various depth of cut 30, 50 and 75 mm respectively. The minimum plant damage 3.9 percent was obtained at 1.0 kmph forward speed of operation with 30 mm depth of cut. The obtained above result from field study has a close agreement with the results reported by Vinayaka *et al.*, (2017) and Manisha Tekade *et al.*, (2007).

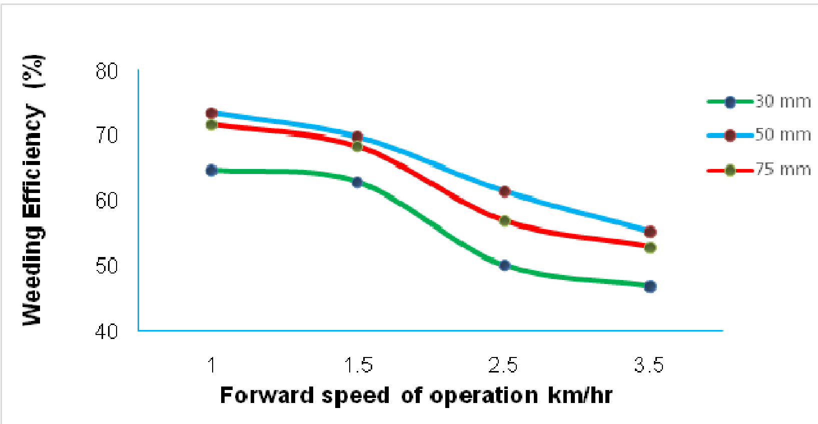

Figure 6: Effect of Forward Speed Operation and Depth of Cut on Weeding Efficiency

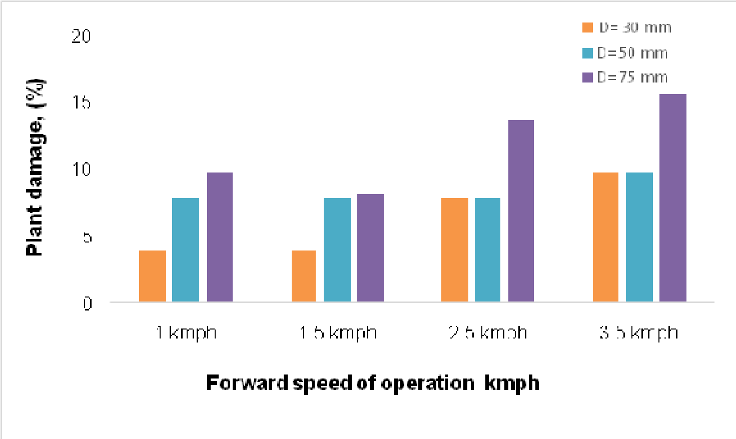

Figure 7: Effect of Forward Speed Operation and Depth of Cut on Plant Damage

Analysis of Variance for Weeding Efficiency

The effect of the forward speed of operation and depth of cut on weeding efficiency and plant damage studied using ANOVA as shown in table 4.1. From the results, it can be observed that forward speed of operation and depth of cut was significantly influenced the weeding efficiency and plant damage at 1 percent level.

Table 1: Analysis of Variance for Weeding Efficiency

Source	df	Sum of Squares	Mean Square	F	PROB	
Forward speed of operation (S)	3	1740.989	580.329	4484.88	0.000	**
Depth of cut (D)	2	650.1528	325.076	2512.24	0.000	**
S×D	6	15.80	2.634	20.36	0.000	**
Error	22	2.846	0.129	1		
Total	35	2557.93	73.084	564.80		
* 5% significant level; ** 1% significant level; NS – non significant.						

Multiple Linear Regression Analysis for Weeding Efficiency

A multiple linear regression analysis was carried out with combining independent variables during the field test and the results were presented in Table 2.

Table 2: The Correlation Coefficient of Weeding Efficiency with Influencing Parameters

Parameter	Coefficients
Intercept	68.12
The forward speed of operation (S)	-7.14
Depth of cut (D)	0.141
R Square	0.78

From table 2 a mathematical model correlating the independent variables namely forward speed of operation (S) and depth of cut (D) was arrived as in the following equation

$$\eta_w = 68.12-7.14\ S+0.141\ D \qquad (5)$$

From the above equation, it was found that the dependent parameter weeding efficiency (η_w) has positive relation with depth of cut (D)and negative relation with forward speed of operation (S). The analysis of variance (R^2) was found out as 78 percent.

CONCLUSIONS

The soil resistance linearly increases with an increasing depth of cut, developed unit reduce soil resistance at the maximum level after weeding operation which helps to better crop germination. The maximum weeding efficiency of 73.64 and was achieved at 1.0 kmph forward speed of operation with 50 mm depth of cut. The minimum plant damage of 3.8 percent was achieved at 1.0 kmph forward speed of operation with 30 mm depth of cut. The dependent parameter weeding efficiency (η_w), has positive relation with depth of cut (D) and negative relation with forward speed of operation (S).

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